

Steffi Friedrichs, Nanotechnology Industry Association

Abstract

In the current debates about the potential benefits and risks brought to us by nanotechnologies, the role of standards too often gets overlooked and neglected. Yet, without standards, enabling technologies like nanotechnologies could never be established as reliable innovators.

The collective term 'nanotechnologies' comprises a multitude of process innovations, novel materials, ground-breaking achievements in analysis and measurement techniques, as well as specific novel (additional) functionalities in well-known products. Based on the spread of predicted impacts of nanotechnologies, this emerging technology discipline is already referred to as a 'general purpose technology', which revolutionizes existing technologies like the electricity did before; it will enable significant advancements in existing industrial markets, and is expected to enable the establishment of markets, but it will never be restricted to a single 'nanotechnology market'.

The wide-spread application of nanotechnologies in nearly all known industrial sectors puts particular emphasis on the requirement of well-established standards to support the commercialization of this enabling technology discipline.

Application of documentary standards in the characterisation of manufactured nanoparticles

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Abstract

The reliable characterisation of objects as small as nanoparticles (particles with all three external dimensions < 100 nm) is a scientific and technological challenge. It requires careful and time-consuming sample preparation, expensive equipment and highly-skilled operators to directly visualise single nanoparticles or groups of nanoparticles. Fortunately, a number of sophisticated techniques and instruments have been developed to more rapidly and easily capture relevant aspects of the behaviour of nanoparticles. Some of the measured properties, such as diffusion rate or sedimentation rate, can be related to the size of the particles, thus providing indirect, but rapid measurements of an *equivalent* diameter. It has been predicted and observed that many of the functional properties as well as some of the side effects of nanoparticles are size-dependent. That is why the mentioned indirect techniques to estimate an equivalent diameter for nanoparticles have become an important routine measurement in industrial and research laboratories.

The calculation of the average equivalent diameter of a usually very large population of nanoparticles from the measured collective behaviour of the population of nanoparticles in a dynamic state of agglomeration, brings about a number of conceptual measurement issues. Sampling particles from a large population, changing the particle environment during sample preparation, and the non-linear relation between particle size and particle response, have a complicated effect on the relation between the intended measurands (the equivalent diameter and its distribution or a corresponding dispersity characteristic), and the actual measurement result. Such conceptual difficulties can be partly tackled and overcome via the development and intelligent use of documentary standards, in which a number of measurement parameters are harmonised so as to improve the comparability of measurement results.

In any case, the choice for using a particular measurement standard must be made in a conscious manner. This requires that the measurement laboratory is informed about the intended use of the data it is asked to provide, and that the customer is aware of the meaning of what will be measured (explanation of the measurand). The presentation will address this challenging issue. In addition, it will provide guidance on the use of currently available measurement standards developed in the relevant technical committees of ISO (in particular ISO/TC 24/SC4 'Particle characterisation'). An overview will be given on the development of new standards or the revision and upgrade of existing nanoparticle characterisation standards of relevance to production and laboratory analysts. Examples will be drawn from the work in ISO/TC 24/SC 4, as well as from the work programme of the ISO/TC 229 and CEN/TC 352 technical committees 'Nanotechnologies'.

Metrological challenges in Surface Nano Analysis

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Abstract

Challenging areas for Surface Nano Analysis are nano particles and technology, life sciences and microelectronics. The “classical” methods in Surface Nano Analysis are SIMS, AES and XPS. Principally they enable lateral nano analysis as well as in-depth resolution at the nano scale. Traceability to the mol or the length unit may be established but this goal needs further elaboration of appropriate methods. A mutual calibration method for ultra thin film (<2 nm) measurements can be established as it has been shown by a Key Comparison of National Metrology Institutes organized by the CCQM at BIPM.

Nanoparticles are a major constituent of products or by-products in production. Environment health and safety issues relating to nanoparticles are a major issue and a principal driver in the development of Documentary Standards (ISO TC 229). Toxic properties are related to particle size distribution, surface chemistry, surface charge and surface area. Regulation will be implemented and metrology is required.

Metrology at the bio surface is a rather new topic and it is driven by the nanobiotechnology sector which is expected to cover several 100 billions of USD in the near future. Key areas are medical devices, personalised medicine, nanomedicine and nanobiosafety. Specific analytical tasks are the identification, distribution and quantification of biomolecules, the immobilisation, orientation and structure of biomolecules and the function and activity of bio-molecules at surfaces.

Standards for Scanning Probe Microscopy

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Abstract

Scanning Probe Microscopy (SPM) is used today not only in research and development but increasingly also in many fields of industrial fabrication and inspection. High-technologies such as semiconductor fabrication and nanotechnology attach great importance to the quantitative information these instruments provide. Furthermore, SPM is often used to certify reference objects intended for the calibration of instruments operating at larger scales such as optical techniques, profilometers, and coordinate measurement systems. Thus, SPM is widely regarded as one of the key measurement methods for both the optimization of established measurement techniques as well as for future technologies, especially nanotechnologies.

Consequently, National Metrology Institutes (NMI) such as PTB face the challenge to provide traceable high-accuracy measurement technology, transfer standards and written documentary standards or guidelines on SPM characterization & calibration methods in order to enable the SPM user to calibrate his instrument traceable to the SI unit metre.

NMIs worldwide have set up special Metrology SPMs combining high-stability SPM and laser interferometry for traceable high-accuracy measurements on the micro- and nanoscale. Already about ten years ago, a set of standards especially adapted to the needs of SPM has been developed in a European Union project, involving European NMIs, industry and academia. Apart from these standards, a large variety of different standards either specially developed for SPM or useable for SPM among other methods have become available on the market. In the past few years, novel 3D standards have been developed in a joint project and then successfully introduced on the market. They rely on the landmark principle, i. e. a set of discrete reference points on a supporting 3D structure. While the basic dimensional calibration of SPM is thus covered quite well by transfer standards, nanometric roughness standards for SPM are currently in an early development phase.

Besides transfer standards, the user needs guidance on how to characterize and calibrate his SPM. In summer 2008 VDI/VDE 2656 – Part 1 was released in its final valid version as whiteprint. It is the first guideline on dimensional SPM calibration worldwide and was developed by a committee comprising representatives from SPM manufacturers, SPM users, academia and other research institutes from central Europe as well as PTB. This document is currently processed in ISO TC 201 SC 9, the committee in charge of SPM standardization, to be included in an international ISO standard in a few years.